Asymmetric Effect, Non Linear ARDL and the J –Curve analysis among EAC Members

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ABSTRACT

This article attempts to explore symmetric effect of exchange rate and its transmission channels on trade balance The recently developed method of Non-linear ARDL were utilized for Quarterly data from 1990 Q1 to 2019Q4 in unexplored areas of East African Community (EAC -5) members. The study found presence of robust symmetric and asymmetric negative effect of exchange rate changes to trade balance only in Uganda, both in short run and long run. Meanwhile, there was no evidence of robust J-curve phenomena within EAC members. Generally, the application of exchange rate policy in improving trade imbalance is doubted within EAC region.

Keywords: *Exchange rate, J curve, EAC, Non linear ARDL*

1.1 Introduction

When a country's balance of trade persistently records deficits, the most important policy is to devalue the exchange rate. Economic theory suggests that, real devaluation (currency depreciations) improve trade balance if Marshall-Lerner (ML) is satisfied. Later it was proven empirically that, even if the ML condition is met, balance of trade may still deteriorate (see, Bahmani and Oskoee, 1985). In a more recent extensive review of past studies analyzing ML conditions, Mohsen Bahmani et al (2013) concluded that the argument that ML condition is met does not hold true.

As a result, the effect of devaluations (currency depreciation) of exchange rates to the balance of trade has been an issue of intense debate to both, academicians and policy makers. It is believed that, response of trade balance after real devaluations differs in the short and long run. It is suggested that, after the real devaluations (currency depreciations) of exchange rate, trade will worsen (deficits) in the short run, but the trade balance improves from deficits to surplus in the long run; which generate a shaped called J-curve. Nevertheless, one common assumptions of previous studies were that the adjustment of exchange rate on trade balance are symmetric; which implies that if devaluation of currency (depreciation) improves trade balance, then appreciation retards the trade balance. Meanwhile most of the previous studies relied to the standard ARDL method developed by Pesaranet al (2001) which assumes linear relationship among the variables within the regressions. However, since the development of recent methods of nonlinear ARDL (NARDL) by Shin et al (2014),a third group of studies have emerged to re-examine J curve for the different economies since early 2015. For example, Bahmani-Oskooeeand Fariditavana (2016) for US and its six major trading patners, Bahmani-Oskooee and Fariditavana (2016) for Canada, China, Japan and US, and Bahamni-Oskoee and Kanitpong (2017) for seven Asian countries.

The NARDL has enabled the test to determine whether changes of exchange rate on trade balance are symmetric or asymmetric. Such examination is important for policy making in international economies, especially for emerging economies which are in a policy dilemma to ensure effective and efficient use of available economic resources. This study aims to uncover this gap to the EAC-5 countries, whereby to the best of the author's knowledge, the discussion on the subject matter is still lacking. For example the study by Bahmani-Oskoee and Gelan (2012) in African countries were very limited to only using ARDL method and exploited only two countries within the EAC region[1]. As the region is still in the process of monetary union, whereby protocol for establishment was signed on 30 November 2013, this study would be useful and timely. Furthermore, it is worth to examine the effectiveness of monetary policy which includes exchange rate fluctuations, hence understanding its effects towards trade flows. This article consists of four further main sections. The second section explores empirical studies related to the topic, while the third section describes the methodology. The fourth section discusses the results and its implications, while the final section ends with conclusion and recommendations.

[1] The paper also restricted with using old data from 1970s to 2008, while this study using recently data from 1990-2019.

1.2Methodology

Following the literature review, domestic income, foreign income, and real effective exchange rate were identified to be the main determinants of trade balance in each country. Thus, following the literature we adopt the following specification:

$$LnTB = \beta_O + \beta_1 Y_{yd},_t + \beta_2 YW_t + \beta_3 REFX_t + \varepsilon_t \quad \text{.....(1)}$$

TB is the trade balance, measured as a country's imports divided by her exports to the rest of the world.It measures the trade balance in nominal or real terms (Mohsen Bahmani-Oskooee, 1991). In this study, TB denotes a measure of Tanzania trade balance of industry i with respect to her trading partner at time period t .In equation (1), Y is a measure of domestic economic income with proxy of GDP; as domestic economy grows, its imports rise, so an estimate of $\beta_1$is expected to be positive. On the other hand, an increase in world income (YW) is expected to increase exports, henceforth β_2 is expected to be negative. The choice of imports over exports is due to the definition of real effective exchange rate, $REFX$. By way of construction, since a decline in $REFX$ reflects a real depreciation, if it is to improve the trade balance, the trade balance must be defined as imports over exports. Thus, REFX represent real effective exchange rate and due to its construction, should there be a real depreciation of domestic currency, it will stimulate exports and discourage imports, hence an estimate of β_3 is expected to be positive. The data for all variables were collected from UNCTAD online data base 2018. In order to capture short run dynamics, error correction modeling format has to be incorporated. This is done by adopting Peseranet.al.'s (2001) bounds testing approach known as linear ARDL.

We suspect the reason that previous studies as modeled in equation (1) failed to support for the J-curve effect is due to the belief that there is symmetric effect of exchange rate on trade balance. To this end, to detect if there is a symmetry or asymmetry effect of exchange rate changes on trade balance, this paper utilizes the idea of Shin et al. (2014) to separate depreciations from appreciations. For this, the movement of the $LnREFX$ variable is decomposed into positive (dollar appreciation) and its negative (dollar depreciation) partial sum as:

$LnREFX = LnREFX_0 + LnREFX^+_t + LnREFX^-_t$ where $LnREFX^+$ and $LnREFX^-$, are partial sum process of positive and negative changes in $LnREFX$. To be specific, we can represent as:

$$POS = LnREFX_t^+ = LnREFX = \sum_{p=1}^{t} LnREFX_p^+ = \sum_{p}^{t} \max(\Delta LnREFX_{p,}, 0), \quad \text{.....(3)}$$

$$NEG = LnREFX_t^- = LnREFX = \sum_{p=1}^{t} LnREFX_p^- = \sum_{p}^{t} \max(\Delta LnREFX_{p,}, 0), \quad \text{.....}$$

To this end, with reference to Shin et al. (2014), we replaced $LnREFX$ from equation (2)with POS and NEG variables as in (4):

$$\Delta LnTB = \alpha + \sum_{k=1}^{k} \phi \Delta LnTB_{t-k} + \sum_{k=0}^{k} \rho \Delta Y_{yd,t-k} + \sum_{k=0}^{k} \lambda \Delta YW_{t-k} + \sum_{k=0}^{k} \eta \Delta POS_{t-k} + \sum_{k=0}^{K} \pi NEG_{t-k} + \quad \text{..... (4)}$$
$$\delta_1 LnTB_{t-1} + \delta_2 LnY_{yd,t-k} + \delta_3 LnYW_{t-k} + \delta_4 LnPOS_{t-k} + \delta_5 LnNEG_{t-k} + \xi$$

The introduction of new variables in model (4) allows us to test whether any shock on exchange rate have asymmetric or symmetric effects on Tanzania's trade balance (LnY) with its trading partners $(LnYW)$. The ECM model (4) is the so called nonlinear ARDL model and nonlinearity comes through partial sum or cumulative sum process of generating the two new variables POS and NEG. Shin et al. (2013) made clear justification to apply Pesaran et al.'s (2001)bounds testing approach to model (4).

1.3 Results and Discussions:

In this section we present the findings of both linear ARDL model (2) and non-linear ARDL model (4) for each of EAC countries namely Burundi, Uganda, Kenya, Rwanda and Tanzania. Since African countries started to liberalize their economies in terms of free exchange rate and trade openness in early 1990s, the study utilize quarterly data from the first quarter (Q1) of 1990to the fourth quarter (Q4) of 2019. For any missing quarterly data from any country, we used the interpolation method by Denton (1971) as the best technique to generate data from lower frequency (annual data) to higher frequency (quarterly data). The method is widely recommended by IMF as it is relatively simple, robust, and well-suited for large-scaled applications (IMF, 2012). Since interpolation process occurred with transient movement at the beginning of the interpolated series, eviews 10 software uses Cholette's (1984) modification of Denton's original method in order to remove such problem.

Given our sample size, the maximum lag set are eight, with Akaikes Information Criterion (AIC) used as criterion for model selection. Meanwhile all results presented in Table 1 are obtained from the optimum model selected. All estimates with their diagnostics test results for linear ARDL labeled L-ARDL and non-linear ARDL labeled N-ARDL are given in Table 1. To have a clear understanding, the results were categorized into three separate panels; panel A constitutes short run estimates, panel B presents long run estimates and panel C on diagnostics test. As commonly practiced, the results of the statistical interpretation were denoted as (*) and (**)statistical significant at 10 and 5 percent respectively. Stability test is also important to ensure that our selected model is stable at a given time period. The CUSUM and CUSUMSQ tests were used to analyze the stability. The letter 'S' denotes that the model is stable, while the letter 'U' implies that the model is not stable. Before estimated long run effect of exchange rate the unit root test revealed that all data are stationary after first difference[2].

Panel A (Table 1), suggest that among EAC members, only Uganda and Tanzania have real exchange rate of at least one significant (at 5 percent level of significance) short run negative coefficient. However, for Uganda, both short and long run coefficient of exchange rates were negative and significant. In most cases, these results support the views of Bahmani-Oskoee and Gelan (2012) who also found the absence of J-curve in Kenya and Burundi and other African countries. The significant negative coefficient attached to exchange rate at lower lag followed by the significant positive coefficient at higher lag is only evidenced in Tanzania, which implies traditional 'J-curve' phenomena. These results somehow contradict with those suggested in Bahmani-Oskoee and Gelan (2012) who found no J-curve exist in Tanzania. Considering, the new definition of J-curve according to Rose and Yellen (1989), none of the cases for exchange rate were positive and significant in the long run, which implies J-curve does not exist. The results are aligning with Rose and Yellen (1989) and Bahmani-Oskoee and Fariditavana (2015). The significant long run negative coefficient attached to exchange rate exist only in the case of Uganda, implying devaluation of currency worsens its trade balance. The cointegration results are only meaningful for F-test or ECMt-1 is significant. Looking at F-test results, it is greater than its upper bound critical value of 3.52 for four countries out of five, which implies cointegration is meaningful to all EAC members except Kenya.

However, when using the other technique of lagged error correction term ECMt-1 for previous insignificant F-test for Kenya, the result was negatively significant, which implies the cointegration is meaningful and supports adjustment towards equilibrium to all countries. For the control variables, both in short and long run, world (foreign) income improves trade balances in Uganda and Tanzania as expected. Also for domestic income, it has negative significant effect as expected both in short and long run in Burundi, Uganda and Tanzania, which implies that as domestic income increase deteriorates trade balance of member countries. The negative effect of domestic income is also consistent with Bahmani–Oskoeeet al (2018) for China, South Africa and Russia. This suggests that these countries have to adopt import substitution policy so that to favor their own domestic production. Panel C presents the results of diagnostics statistics whereby all countries passed the selected diagnostics tests. The stability test of CUSUM and CUSUM SQ both imply that the model is stable in all countries which is indicated by the letter 'S'.

Moving further, analysis of asymmetric effect of exchange rate on trade balance using NARDL is also presented in Table 1 for all five countries. Similarly, the results remain only significant both in short and long run in Uganda while others are insignificant. This can be attributed to the fact that the volume of import and export do not respond

[2] The results of unit root are available to the author upon request

adequately to changes in the exchange rate and inelastic demand of trade flows in EAC members. Comparing the results of linear and non-linear effect in Uganda in the short and long run, both symmetric and asymmetric (depreciation or appreciation) have negative effects to trade balances. This implies that the monetary policy of Uganda attached with exchange rate control has to be implemented with great caution. This can be claimed due to the inelastic import demands of the Ugandan economy while its export still relies on agricultural products and raw materials which are vulnerable to higher risks of price fluctuation. For the control variables, World (foreign) income has positive significant effect on trade balances in Kenya and Uganda for the short run period, while in the long run the effect remain positive only in Uganda. However, effect of world income has negative effect on the trade balances of Kenya and Tanzania in the long run, implying as world income grows, import of Kenya and Tanzania also grow contrary to our expectation. For domestic income, the effect is insignificant in all countries both in short and long run.

Table 1: Symmetric and Asymmetric effect of exchange rate changes on trade balance

				1. Rwanda					
Lags	0	1	2	3	4	5	6	7	8
$\Delta LnTB$		-0.075 (0.00)*	-0.26 (0.00)*	-0.26 (0.00)*	-0.63 (0.01)*	-0.92 (0.00)*	-0.66 (0.08)*	0.55 (0.06)*	
ΔLnY	0.00(0.99)								
$\Delta LnYW$	0.73 (0.23)	-0.09 (0.41)	0.17 (0.89)	-0.57 (0.26)	0.47 (0.00)	-0.04 (0.00)			
$\Delta LnREFX$		-0.304 (0.85)							
Panel B:	**Long run estimates**								
	Constant	ΔLnY	$\Delta LnYW$	$\Delta LnREFX$					
	-77.13	0.01(0.99)	0.03(0.01)*	0.35(0.86)					
Panel C:	**Diagnostic test statistics**								
	F	ECM_{t-1}	LM	RESET	CUSM	CUSM^2	R^2		
	10.16*	-0.01(0.00)	2.52	0.14	S	S	0.62		
Section II:	**Full information estimates of non linear ARDL model (8)**								
Panel A	**Short run estimates**								
$\Delta LnTB$									
ΔLnY	1.39(0.12)								
$\Delta LnYW$	-0.9(0.4)								
ΔPOS	-0.51(0.12)								
ΔNEG	-0.62(0.14)								
Panel B	**Long run estimates**								
	Constant	ΔLnY	$\Delta LnYW$	ΔPOS	ΔNEG				
	-0.02(0.0)*	0.08(0.2)	-0.44(0.2)	-0.41(0.23)	-0.16(0.2)				
Panel C:	**Diagnostic test**								
	F	ECM_{t-1}	LM	RESET	CUSM	CUSM^2	R^2		
	12.92*	-0.01	5.52	0.51	S	S	0.75		

2.Kenya									
Lags	0	1	2	3	4	5	6	7	8
$\Delta LnTB$		-0.98(0.01)*							
ΔLnY	-1.93 (0.18)								
$\Delta LnYW$	6.86 (0.18)								
$\Delta LnREFX$	-1.17 (0.26)								
Panel B:	Long run estimates								
	Constant	ΔLnY	$\Delta LnYW$	$\Delta LnREFX$					
	-84.83	-1.96 (0.18)	6.95 (0.10)**	-1.19 (0.26)					
Panel C:	Diagnostic test statistics								
	F	ECM_{t-1}	LM	RESET	CUSM	CUSM^2	R^2		
	26.01	-0.0(0.01)	5.2	0.25	S	S	0.8		
Section II:	**Full information estimates of nonlinear ARDL model (8)**								
Panel A	**Short run estimates**								
$\Delta LnTB$		-1.3(0.02)							
ΔLnY		0.04(0.3)							
$\Delta LnYW$		0.21(0.02)*							
ΔPOS		0.7(0.2)							
ΔNEG		-0.21(0.3)							
Panel B:	**Long run estimates**								
	Constant	ΔLnY	$\Delta LnYW$	ΔPOS	ΔNEG				
	319.12(0.00)*	-0.72(0.12)	-0.21(0.01)*	0.55(0.21)	-0.21(0.2)				
Panel C:	**Diagnostic test statistics**								
	F	ECM_{t-1}	LM	RESET	CUSM	CUSM^2	R^2		
	14	-0.01(0.0)*	6.9	3.5	S	S	0.8		

3.Uganda									
Lags	0	1	2	3	4	5	6	7	8
$\Delta LnTB$		-0.92(0.01)*							
ΔLnY	-0.28 (0.00)*								
$\Delta LnYW$	0.14 (0.03)*								
$\Delta LnREFX$	-3.30 (0.02)*								
Panel B:	**Long run estimates**								
	Constant	ΔLnY	$\Delta LnYW$	$\Delta LnREFX$					
	-167.90	-0.30 (0.00)	0.14 (0.03*)	-0.35* (0.02)					
Panel C:	**Diagnostic test statistics**								
	F	ECM_{t-1}	LM	RESET	CUSM	CUSM^2	R^2		
	23.27	-0.0(0.0)*	2.52	3.4	S	S	0.8		
Section II:	**Full information estimates of non linear ARDL model (8)**								
$\Delta LnTB$		-2.76(0.01)*							
ΔLnY		-75.49(0.21)							
$\Delta LnYW$		34.49(0.01)*							
ΔPOS	-0.3(0.20)*								
ΔNEG	-2.91(0.01)								
Panel B	**Long run estimates**								
	Constant	ΔLnY	$\Delta LnYW$	ΔPOS	ΔNEG				
	0.56(0.01)*	-0.35(0.11)	0.24(0.01)*	-0.13(0.01)*	-0.05(0.0)*				
Panel C	**Diagnostics test statistics**								
	F	ECM	LM	RESET	CUSM	CUSM^2	R^2		
	14	-0.1(0.01)*	5.35	5.25	S	S	0.		

4. Tanzania									
Lags	0	1	2	3	4	5	6	7	8
$\Delta LnTB$		-0.08 (0.35)	-0.13 (0.12)	-0.26 (0.00)*	0.22 (0.02)*	-0.19 (0.01)*	-0.10 (0.17)	-0.06 (0.34)	0.21 (0.0)*
ΔLnY	-13.70 (0.63)	0.09 (0.01)*	-0.86 (0.04)*	0.33 (0.56)	0.20 (0.06)*	-0.17 (0.00)*	0.05 (0.00)*	0.01 (0.15)	-0.07 (0.11)
$\Delta LnYW$	0.56 (0.00)*	-0.17 (0.00)*	0.35 (0.00)*						
$\Delta LnREFX$	-0.01 (0.00)	0.41 (0.00)*	-0.07 (0.00)*	0.02 (0.20)	-0.22 (0.99)	-0.02 (0.10)**	0.08 (0.00)*		
Panel B:	**Long run estimates**								
	Constant	ΔLnY	$\Delta LnYW$	$\Delta LnREFX$					
	-124.92 (0.06)	-0.42 (0.00)*	0.17 (0.01)*	-0.90 (0.39)					
Panel C:	**Diagnostic test statistics**								
	F	ECM_{t-1}	LM	RESET	CUSM	CUSM^2	R^2		
	6.42	0.01(0.00)*	5.97	-0.14(1)	S	S	0.8		
Section II:	**Full information estimates of non linear ARDL model (8)**								
$\Delta LnTB$	-0.01(0.0)*								
ΔLnY	-0.11(0.1)								
$\Delta LnYW$	-0.21(0.23)								
ΔPOS	-0.51(0.11)								
ΔNEG	-0.31(0.21)								
Panel B	**Long run estimates**								
	Constant	ΔLnY	$\Delta LnYW$	ΔPOS	ΔNEG				
	100	-0.03(0.12)	-0.1(0.01)*	-0.1(0.12)	-0.25(0.1)				
Panel C:	**Diagnostic test statistics**								
	F	ECM_{t-1}	LM	RESET	CUSM	CUSM^2	R^2		
	12	-0.2(0.01)*	2.5	0.14	S	S	0.80		

5.Burundi									
Lags	0	1	2	3	4	5	6	7	8
$\Delta LnTB$		-0.87(0.0)*							
ΔLnY	-0.04(0.02)*								
$\Delta LnYW$	0.02(0.23)								
$\Delta LnREFX$	0.03(0.23)								
Panel B:	**Long run estimates**								
	Constant	ΔLnY	$\Delta LnYW$	$\Delta LnREFX$					
	-100.02(0.0)*	-0.04(0.0)*	0.01(0.3)	0.04(0.21)					
Panel C:	**Diagnostic test statistics**								
	F	ECM_{t-1}	LM	RESET	CUSM	CUSM^2	R^2		
	12.5	-0.01(0.0)*	5.25	2.5	S	S	0.8		
Section II:	**Full information estimates of non linear ARDL model (8)**								
Panel A	**Short run estimates**								
$\Delta LnTB$		-0.81(0.0)*							
ΔLnY	-1.97(0.2)								
$\Delta LnYW$	0.09(0.28)								
ΔPOS	-0.05(0.8)								
ΔNEG	-0.08(0.7)								
Panel A	**Long run estimates**								
	Constant	ΔLnY	$\Delta LnYW$	ΔPOS	ΔNEG				
	-100.2(0.3)	-0.73(0.1)	5.52(0.01)*	-1.1(0.7)	-0.0(0.8)				
Panel C	**Diagnostic test statistics**								
	F	ECM_{t-1}	LM	RESET	CUSM	CUSM^2	R^2		
	10.2	0.01(0.01)*	2.5	2.53	S	S	0.8		

1.4 Conclusion and Recommendations

The results from LARDL suggest that, among the EAC members only Uganda and Tanzania carry the real exchange rate of at least one significant (at 5 percent level of significance).Short run negative coefficient, signifying the evidence of J-curve, is only found for Tanzania. As for Uganda, both short and long run coefficient of exchange rates were negative and significant. For the control variables, both in short and long run, world (foreign) income improve trade balances only in Uganda and Tanzania. Also, domestic income has negative significant effect both in short and long run in Burundi, Uganda and Tanzania. This implies that these countries have to adopt import substitution policy so that to favor their own domestic production. Similarly, the result from NARDL shows that the effects of exchange rate remain negative and only significant both in short and long run in Uganda while others were insignificant. Comparing the results of linear and non linear effect in Uganda for short and long run, both symmetric and asymmetric (depreciation or appreciation) effect have negative effects to trade balances. This implies that, the monetary policy of Uganda attached with exchange rate control has to be implemented with great caution. Once again, it seems monetary policy attached to exchange rate does not have influence in trade balance of EAC members.

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